

West Nile Virus, Disease Transmission, and Disease Reduction: A Brief Overview

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Purpose of this Presentation

- Review epidemic of West Nile virus in Michigan and the United States
- Discuss features of mosquito biology and mosquito-borne viral encephalitis transmission relevant to Michigan conditions
- Review strategies to reduction in mosquito transmitted disease

Mosquito Life Cycle



Adult female



Eggs



Larva

Emergence

Pupa



Michigan Mosquitoes

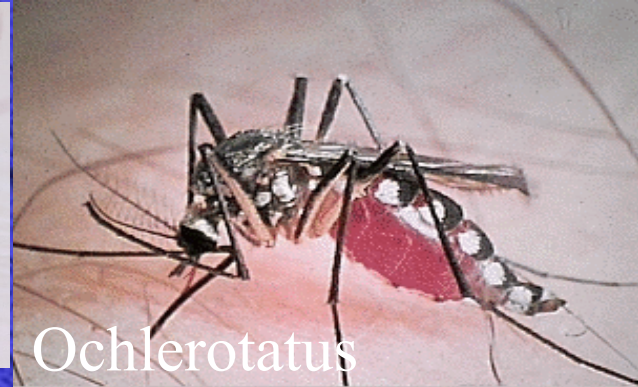
- About 60 species in the state
- Only the females bite, and not all of our species need blood, or bite people
- The overwintering stage is species specific; eggs, larvae, or adult females may overwinter
- Mosquitoes are classified by their shape and anatomy

Two major groupings:

Culicinae



Culex



Ochlerotatus



Aedes

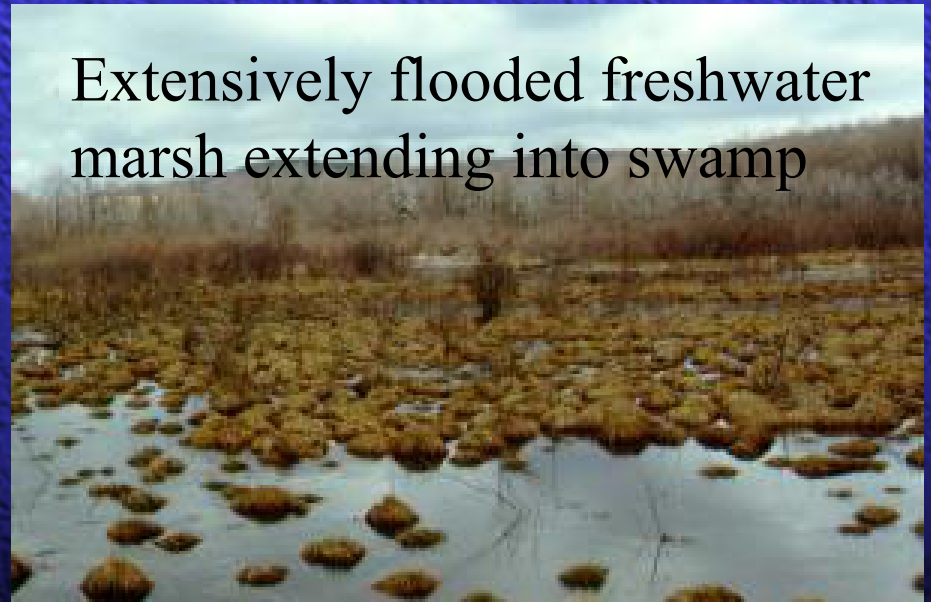
Anophelinae



Anopheles

Generalized Classification Scheme for Michigan Mosquitoes

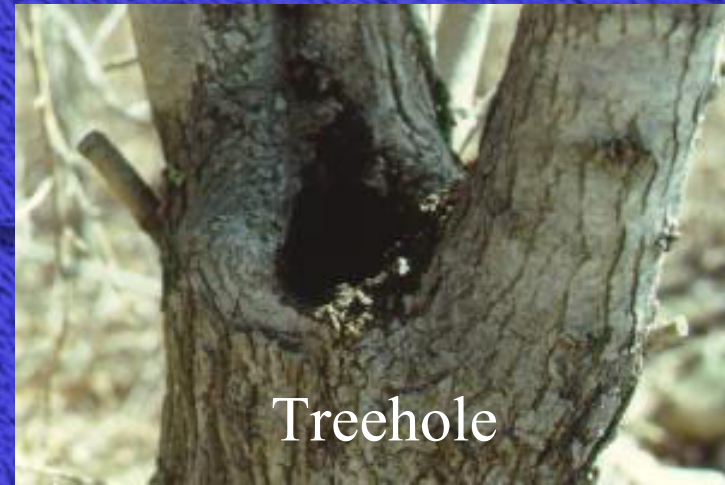
- Spring woodland pool mosquitoes
- Summer floodwater mosquitoes
- Open water mosquitoes
- Container mosquitoes
- There are important exceptions to this classification
- One generation per year; eggs overwinter
- >1 generations in summer; eggs overwinter
- *Anopheles*, *Culex*: females overwinter, >1 generation per summer
- Adapted to small bodies of water held in plants or made by people; overwinter as eggs or larvae
- Examples: waste water and underground mosquitoes



Larval habitat of *Culiseta*
beneath tree hummock



Treehole



Urban street catchbasin



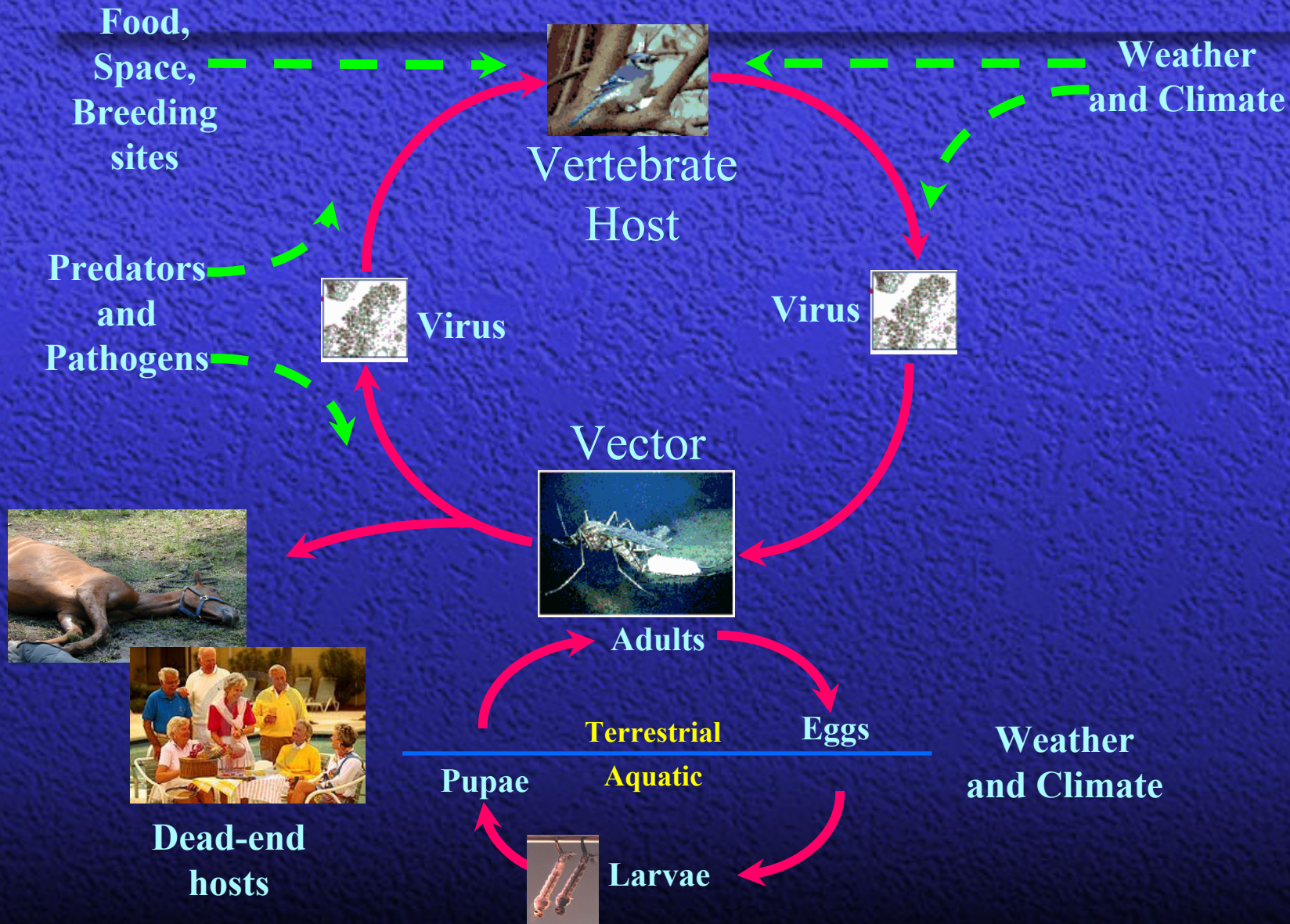
Tires

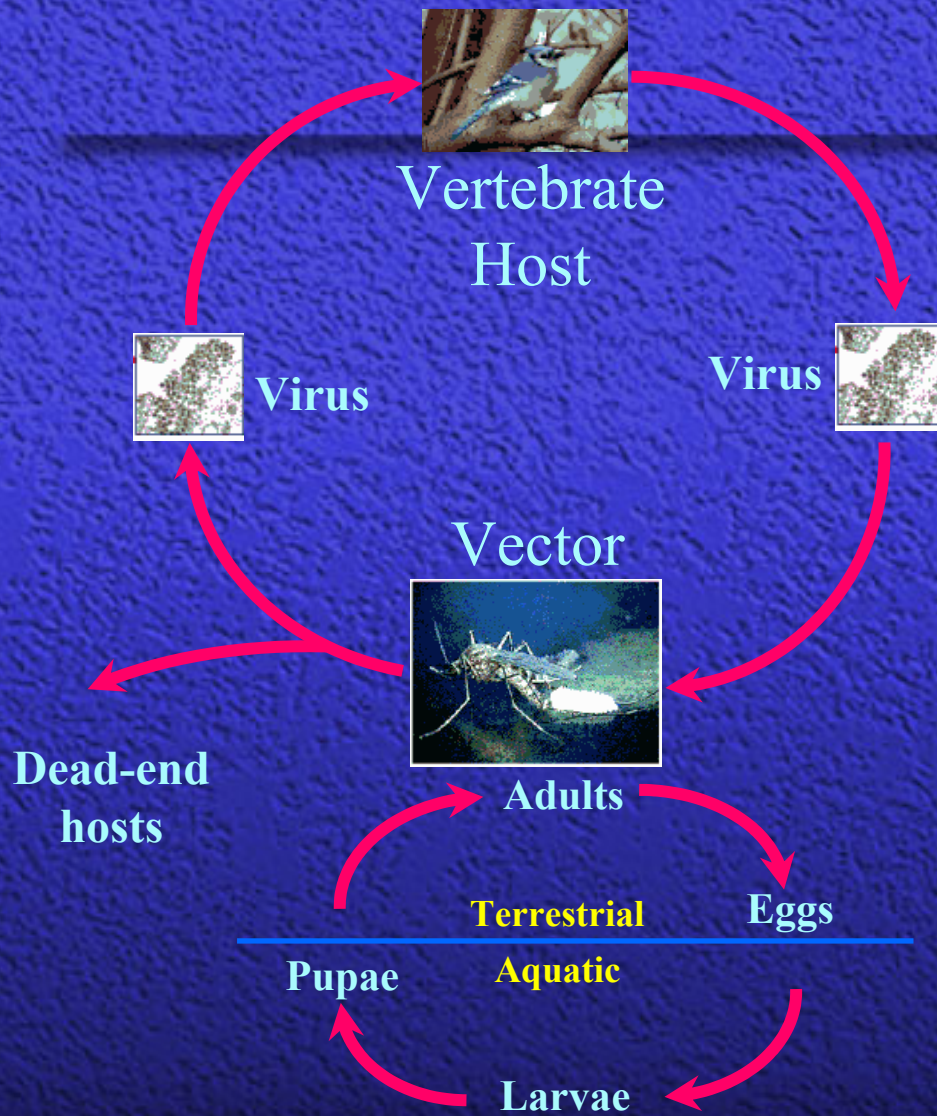


Pitcher



Arbovirus Transmission Cycles are Complex





Virus amplification
in birds and
mosquitoes

Mosquito population
growth

A M J J A S

Arbovirus

[Contraction]

Arthropod-borne virus

Mosquito and tick transmitted
viruses that cause disease in
humans and animals

Vector

An arthropod (such as a species of mosquito or tick) that is capable of transmitting viruses that cause disease in humans and animals

Mosquito-borne Arboviruses

Arboviruses: Not a taxonomic term. Refers to viruses transmitted biologically by blood-feeding arthropods
“**Arthropod-Borne viruses**”

Major groupings of arboviruses:

Flaviviruses (Flaviviridae): yellow fever, dengue;
Japanese encephalitis complex (incl. WNV)

Alphaviruses (Togaviridae): EEE, WEE, VEE;
chikungunya, o'nyong nyong, Ross River

Bunyaviruses (Bunyaviridae): California
serogroup (e.g., LaCrosse virus)

Phleboviruses (Bunyaviridae): Rift Valley fever

Principal Arboviral Diseases, United States

LaCrosse (LAC) encephalitis

St. Louis encephalitis (SLE)

Eastern equine encephalomyelitis (EEE)

Western equine encephalomyelitis (WEE)

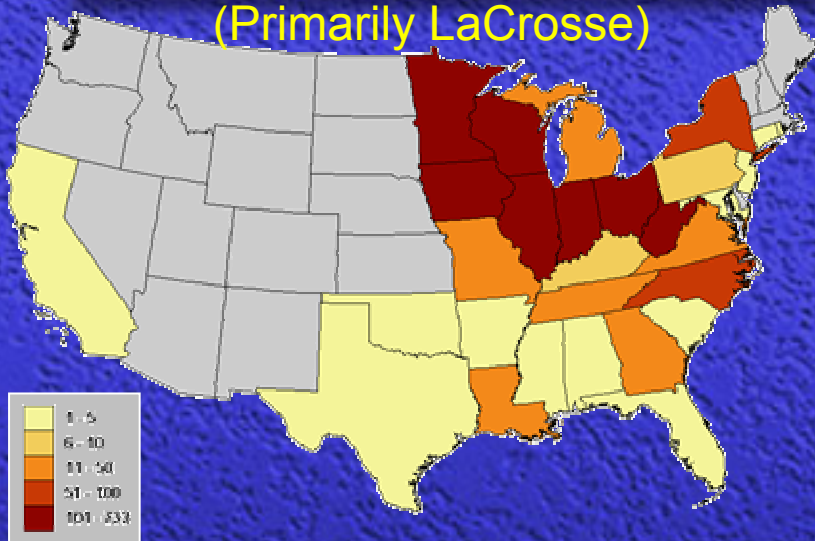
West Nile encephalitis

Dengue

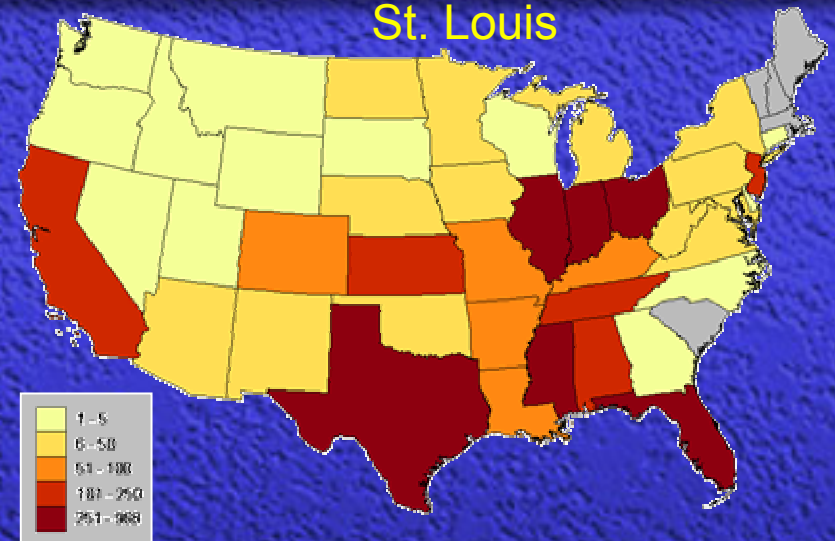
Common Arboviruses in the United States

California Serogroup

(Primarily LaCrosse)



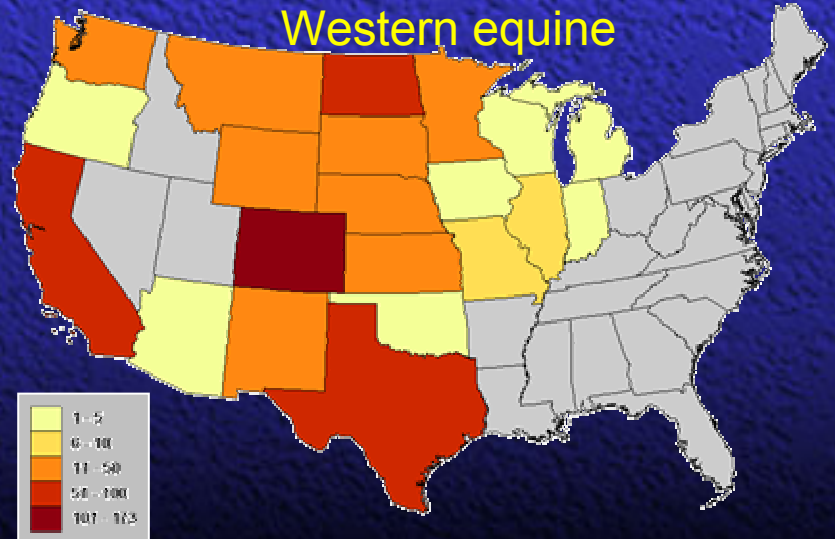
St. Louis



Eastern equine



Western equine



Urban Flavor of SLE and WNV Transmission Cycles

- *Culex* mosquito vectors: larvae associated with waste- and storm-water retention and channeling systems (street catchbasins and stormwater retention catchments are key)
- *Culex* mosquitoes quest for urban bird (crow, other) hosts in the urban green space tree canopy: setting for urban amplification
- Crows have become urbanized
- *Culex* spp. rarely but stealthily feed on humans (late at night; indoors and outdoors; at low densities of exposure)
- Urban virus overwintering in hibernating female *Culex* in refugia (under streets etc)

Cryptic habitats of larval and adult Culex in urban environments

Urban trees provide roost for crows



Manholes leading to
utility workspaces

Catchbasin





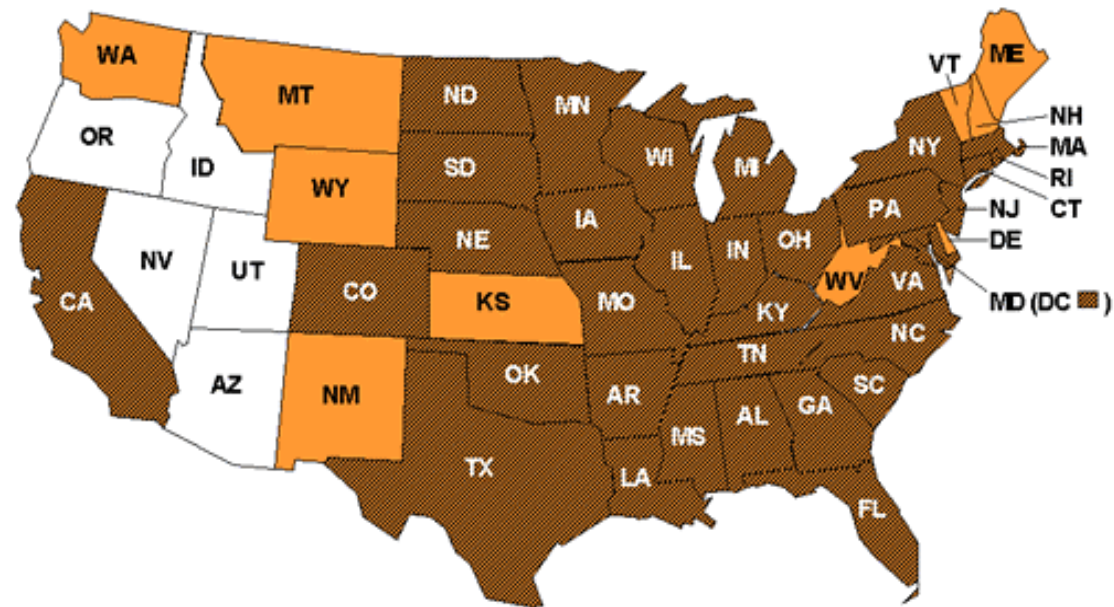
1999



2000

2001

Any WNV Activity Reported - 2002

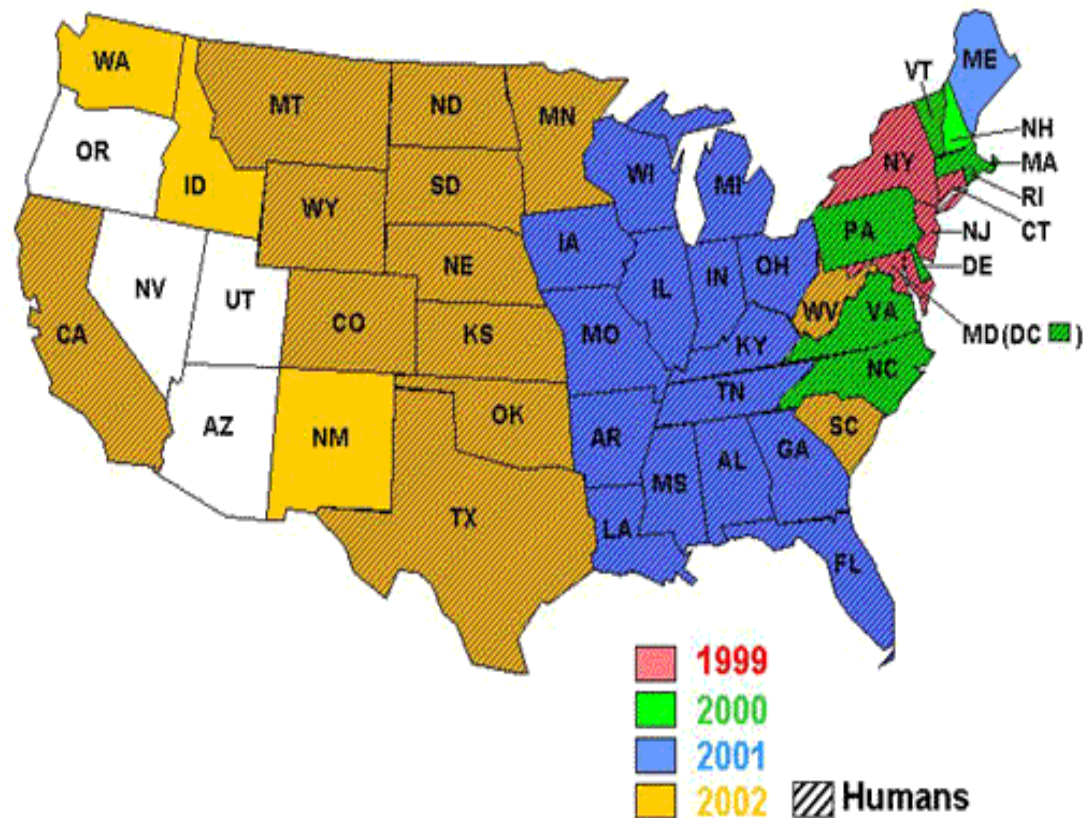
West Nile Virus in the United States, 2002



-  Verified avian, animal, and mosquito infections during 2002, as of October 8, 2002
-  Pattern indicates human case(s)

Human Cases

West Nile Virus in the United States, 1999 - 2002



Michigan Department of Community Health Announces Probable Human Cases of West Nile Virus

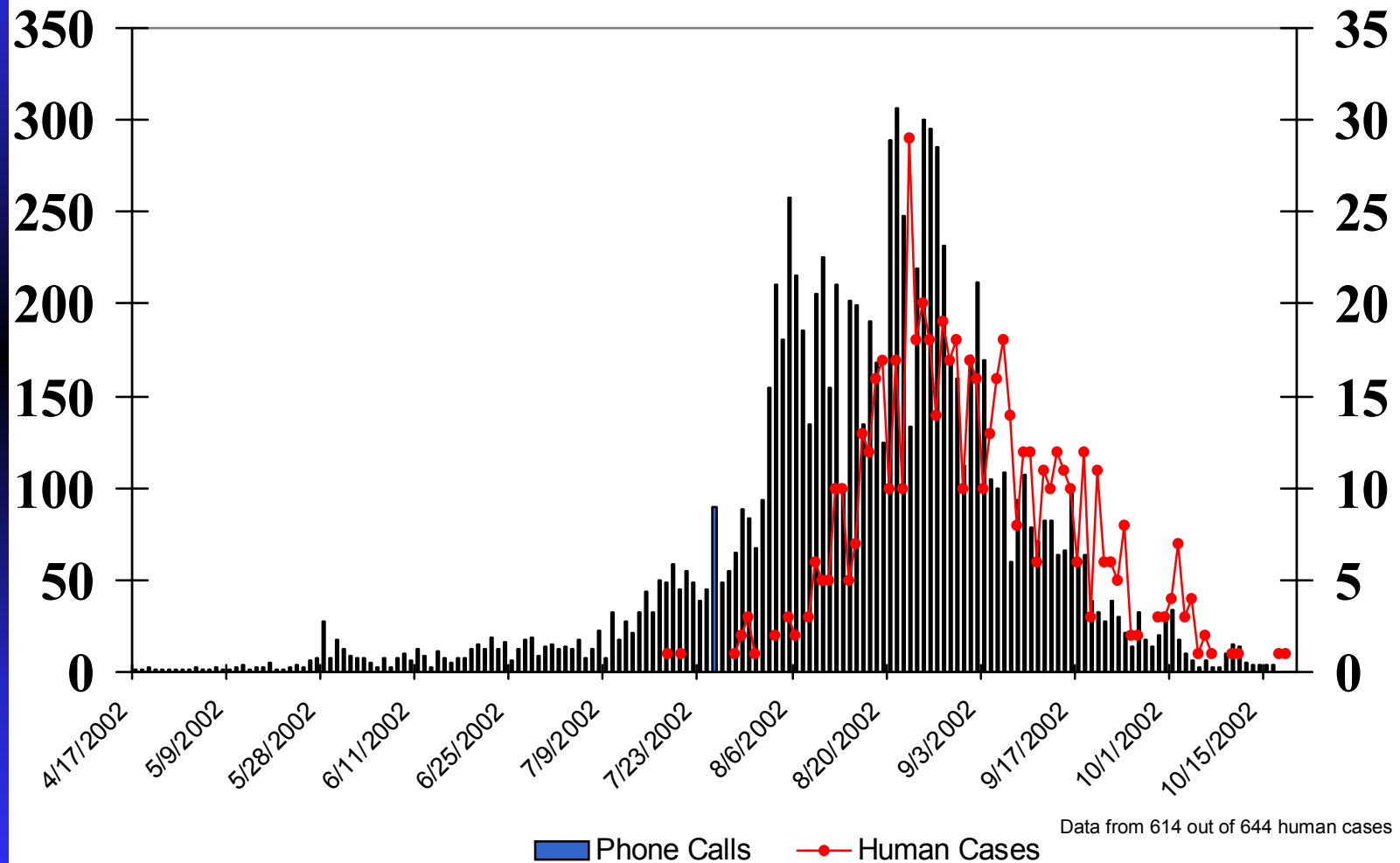
August 16, 2002

Michigan Department of Community Health Chief Medical Executive, David R. Johnson M.D., today announced two probable human cases of West Nile virus. Laboratory samples have been sent to the Centers for Disease Control and Prevention for confirmatory testing.

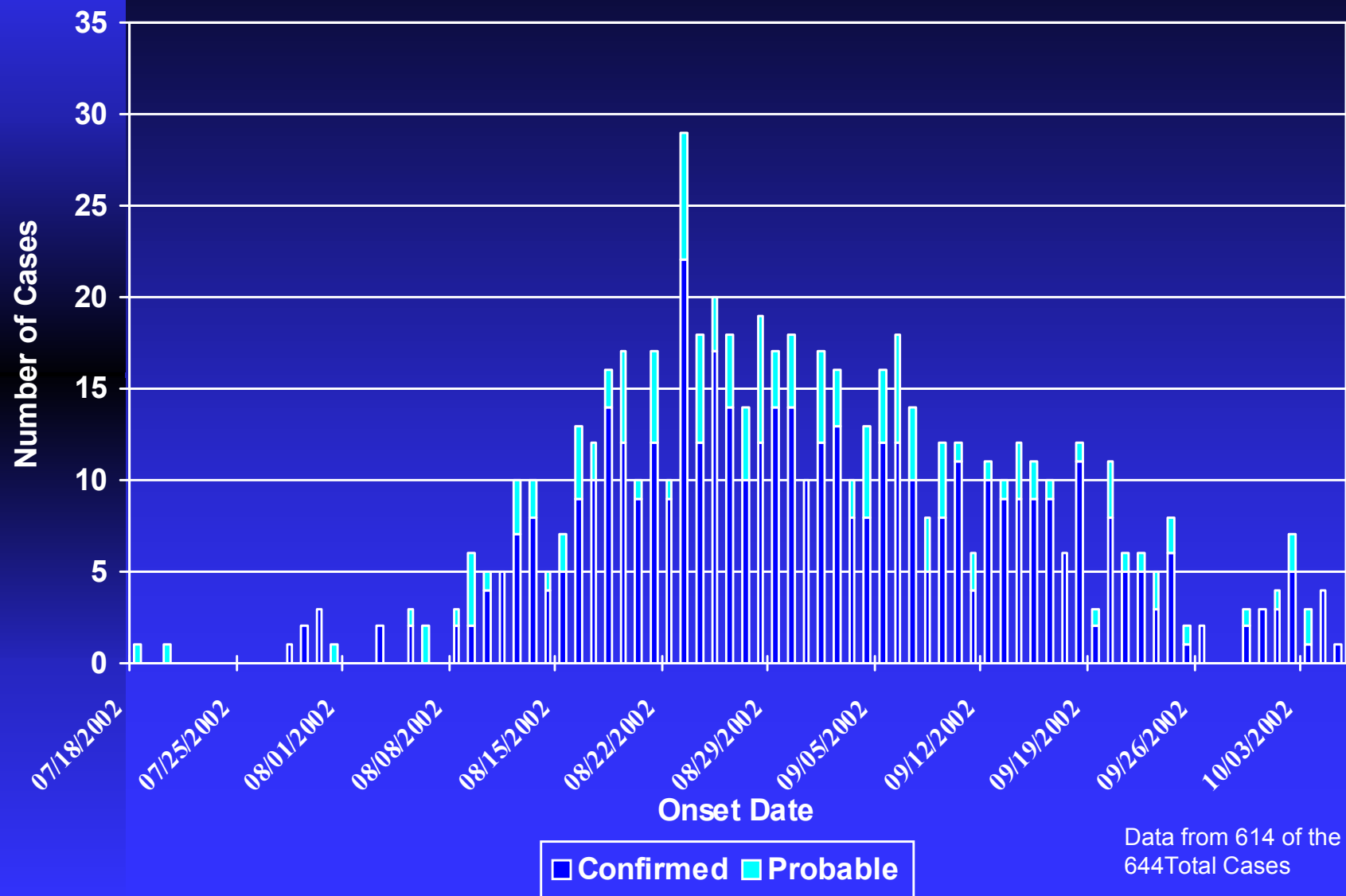
The first case involves an 82 year-old male from Southeast Michigan who was hospitalized and has been released in good condition. The second involves a 63 year-old male from Southeast Michigan who is currently hospitalized and appears to be improving.

“We are encouraged that both of these gentlemen appear to be recovering and we will continue to work with health care providers throughout Michigan to quickly identify any other potential human cases,” said Dr. Johnson. “The most important thing a person can do to protect themselves from West Nile virus is to follow the common-sense precautions to minimize exposure to mosquitoes.”

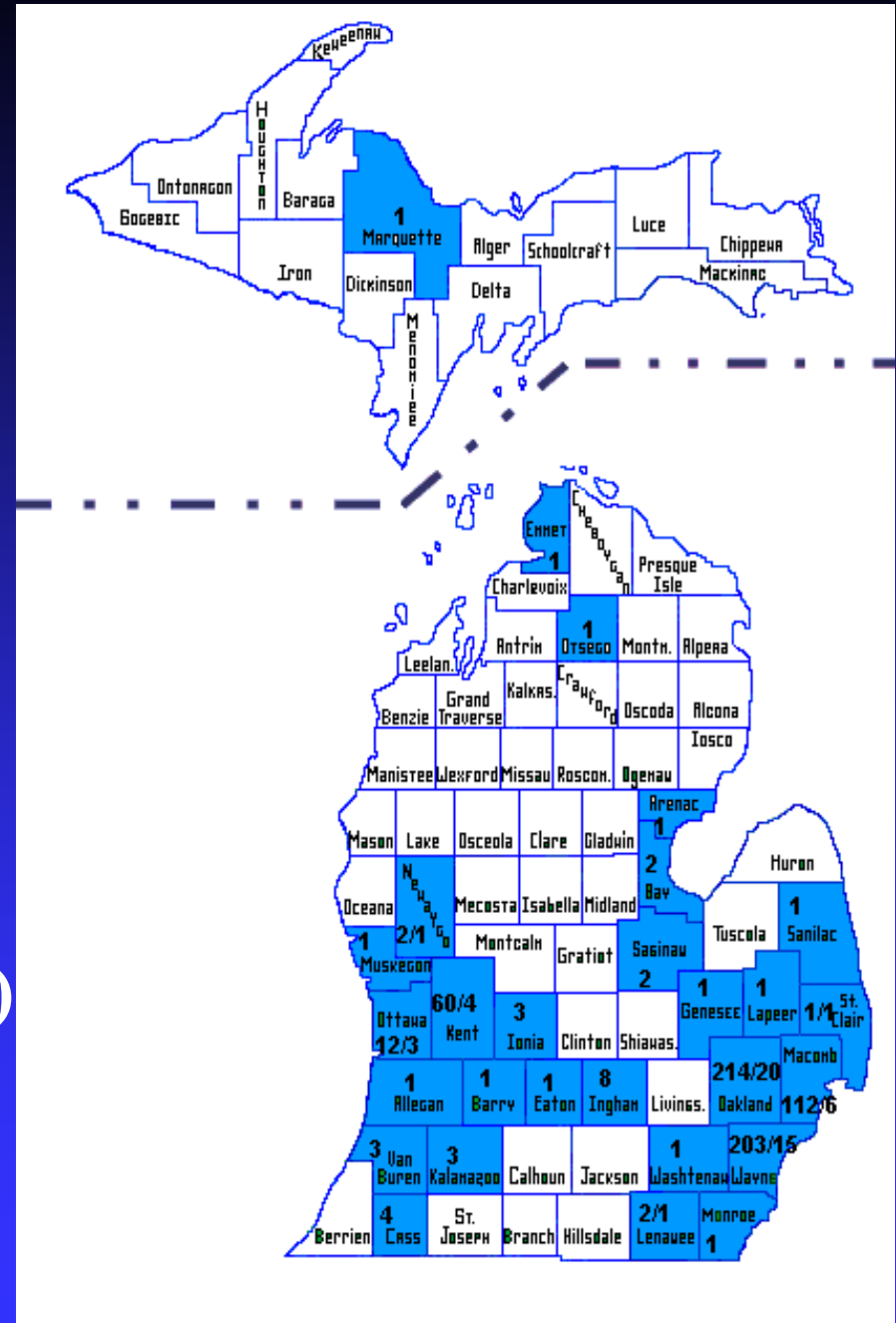
Phone Reports of Dead Birds versus Human Cases in Michigan for 2002



Onset Date of Symptoms Among Human West Nile Virus Cases in Michigan for 2002



644 cases
51 deaths
***(Total Cases/Deaths)**



West Nile Virus Case Summary

Total Laboratory Positive Cases: 644

West Nile Meningo-encephalitis cases: 559 (87%)

Age range: .75-95 yrs

Average age: 57.8 yrs

West Nile Fever cases: 57 (9%)

Age range: 3-80 yrs

Average Age: 47.7 yrs

Unknown cases: 28 (4%)

Deaths: 51 (9%)

Age range: 24-95 yrs

Average age: 74.5 yrs

Additional Arboviruses in 2002

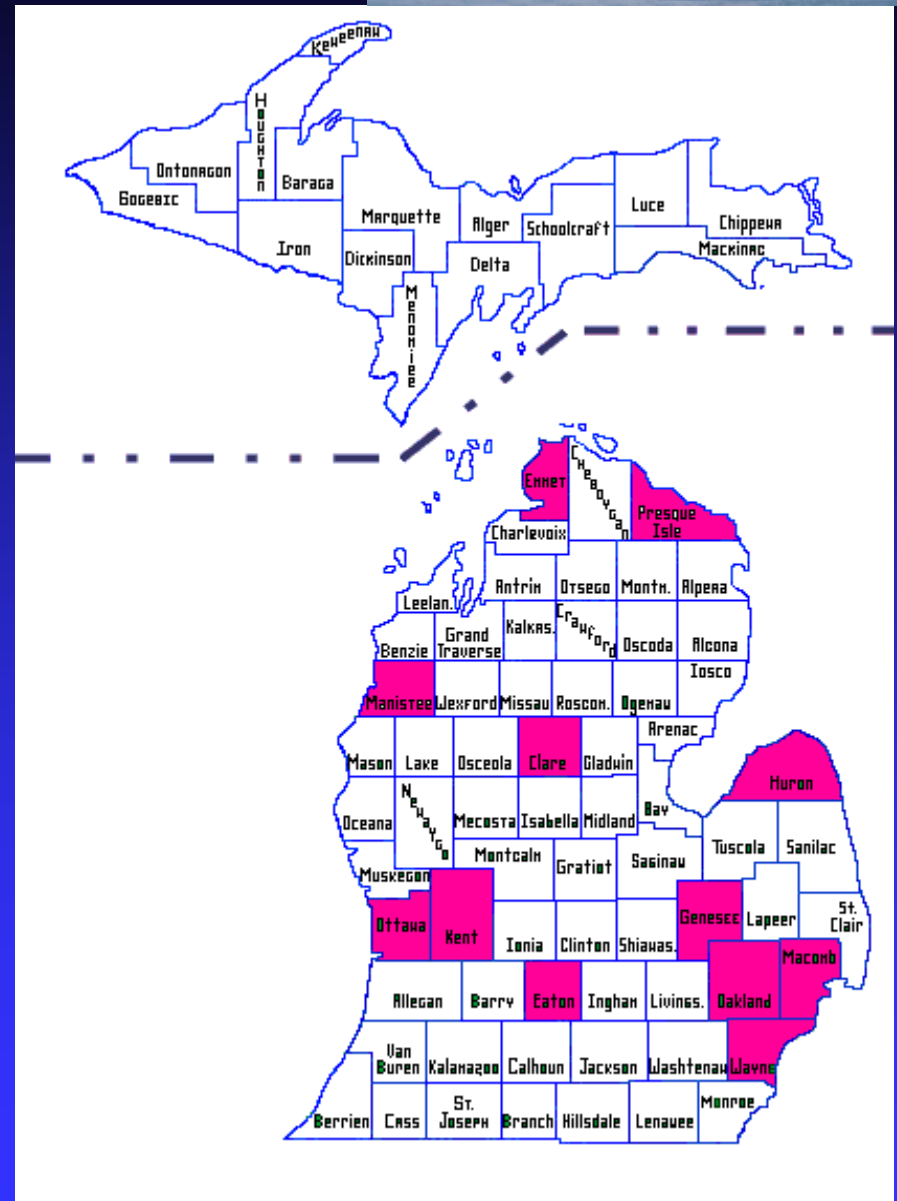
- St. Louis Encephalitis: 3 cases
- Eastern Equine Encephalitis: 6 cases
- LaCrosse Encephalitis: 11 cases
- Powassan virus: 1 case (Emmet Co.)
(tick borne encephalitis)

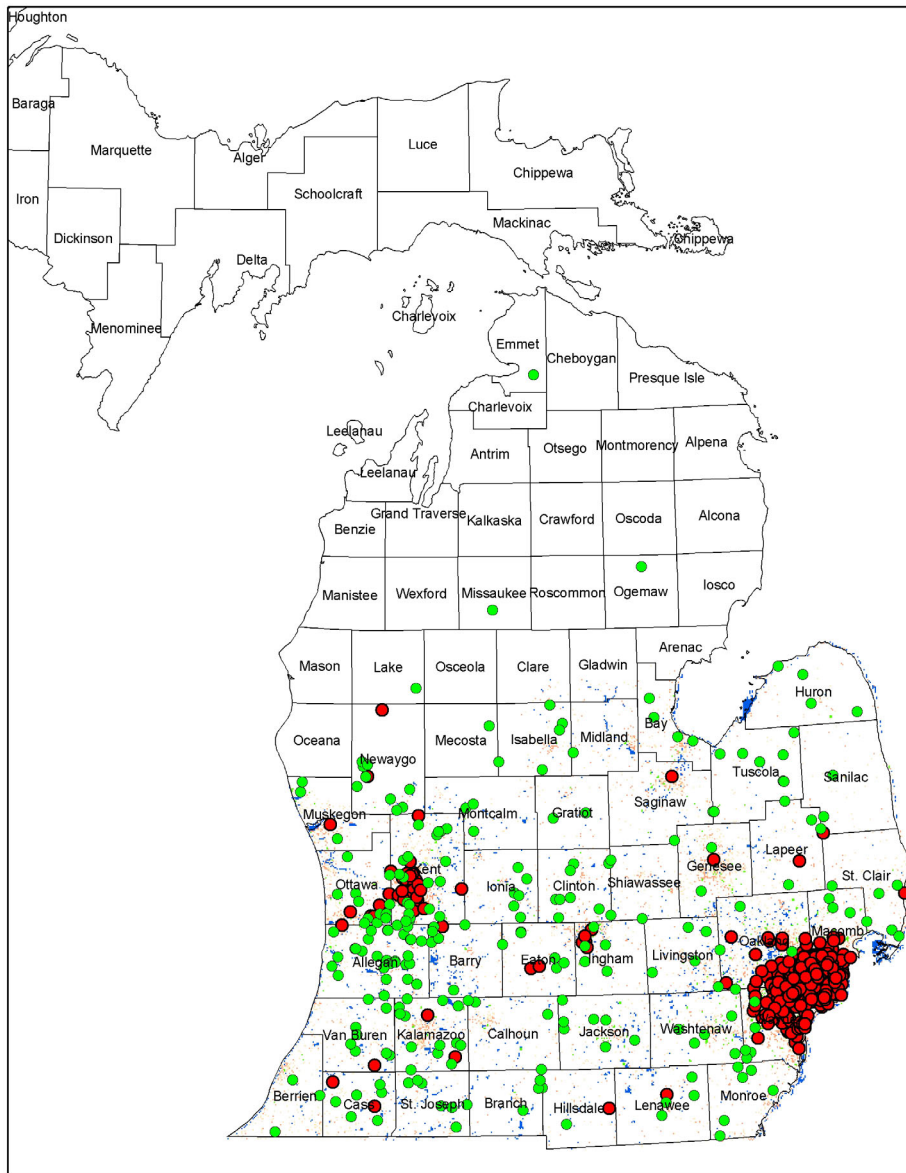
First time ever documented case in
Michigan!

Additional Arbovirus Cases

Michigan, 2002

County	SLE	EEE	LAC	POW
Clare			1	
Eaton			1	
Emmet				1
Genesee			3	
Huron	1			
Kent			1	
Macomb		2	1	
Manistee			1	
Oakland		1	2	
Ottawa		1		
Presque Isle			1	
Wayne	2	2		





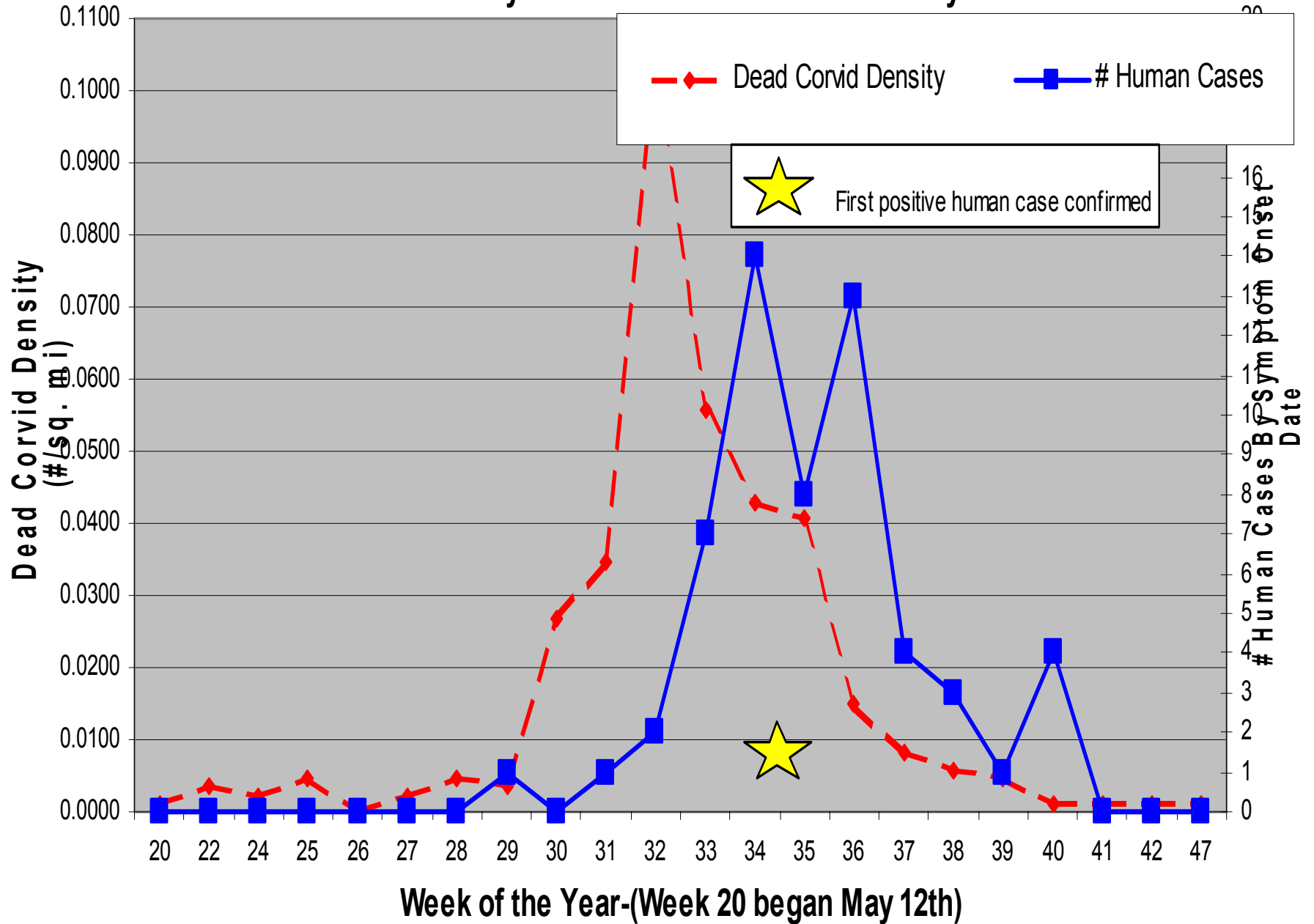
0 10 20 40 60 80
Miles

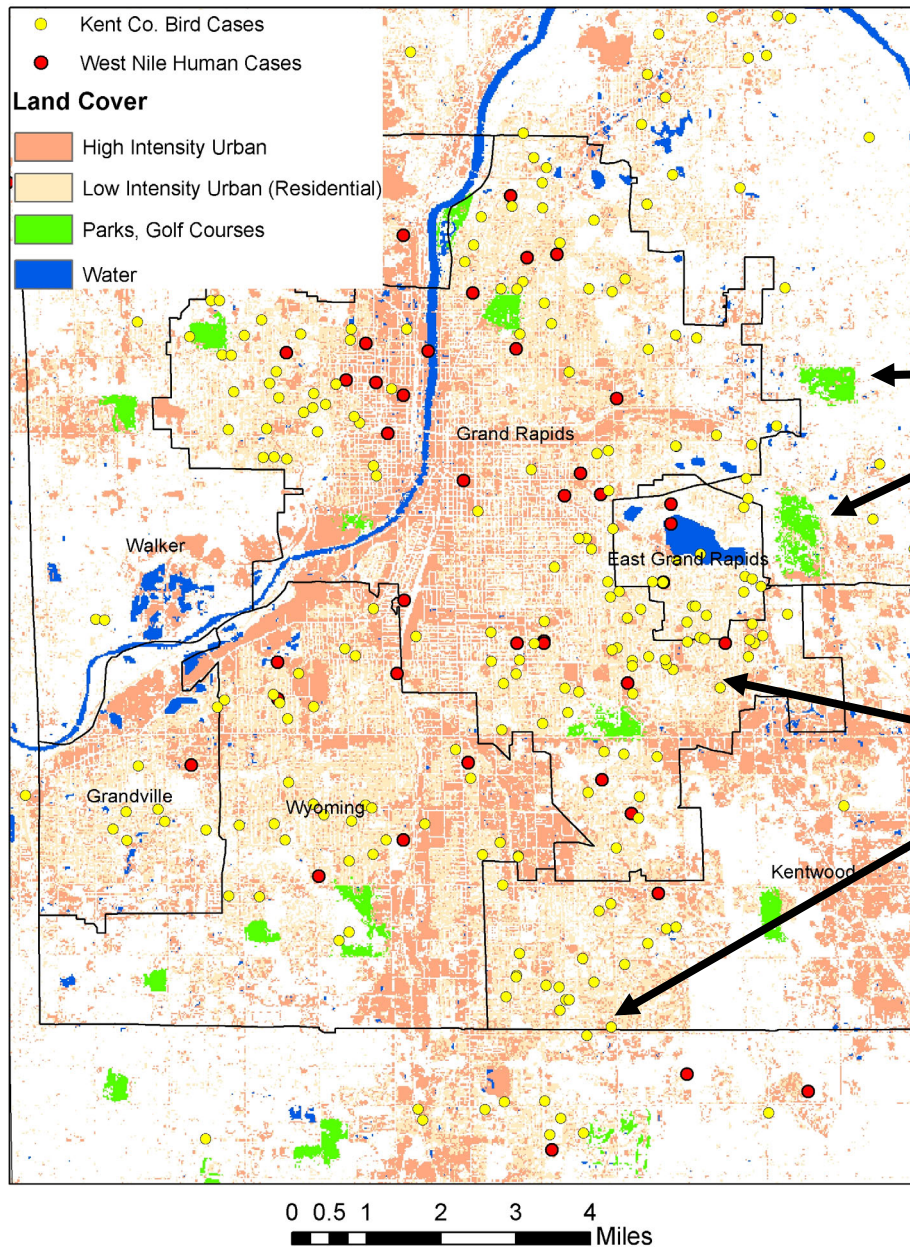


- WNV horse cases -329
- WNV human cases -644



Dead Corvid Density vs. Human Cases for Kent County in 2002





Metro Grand Rapids WNV human and bird cases

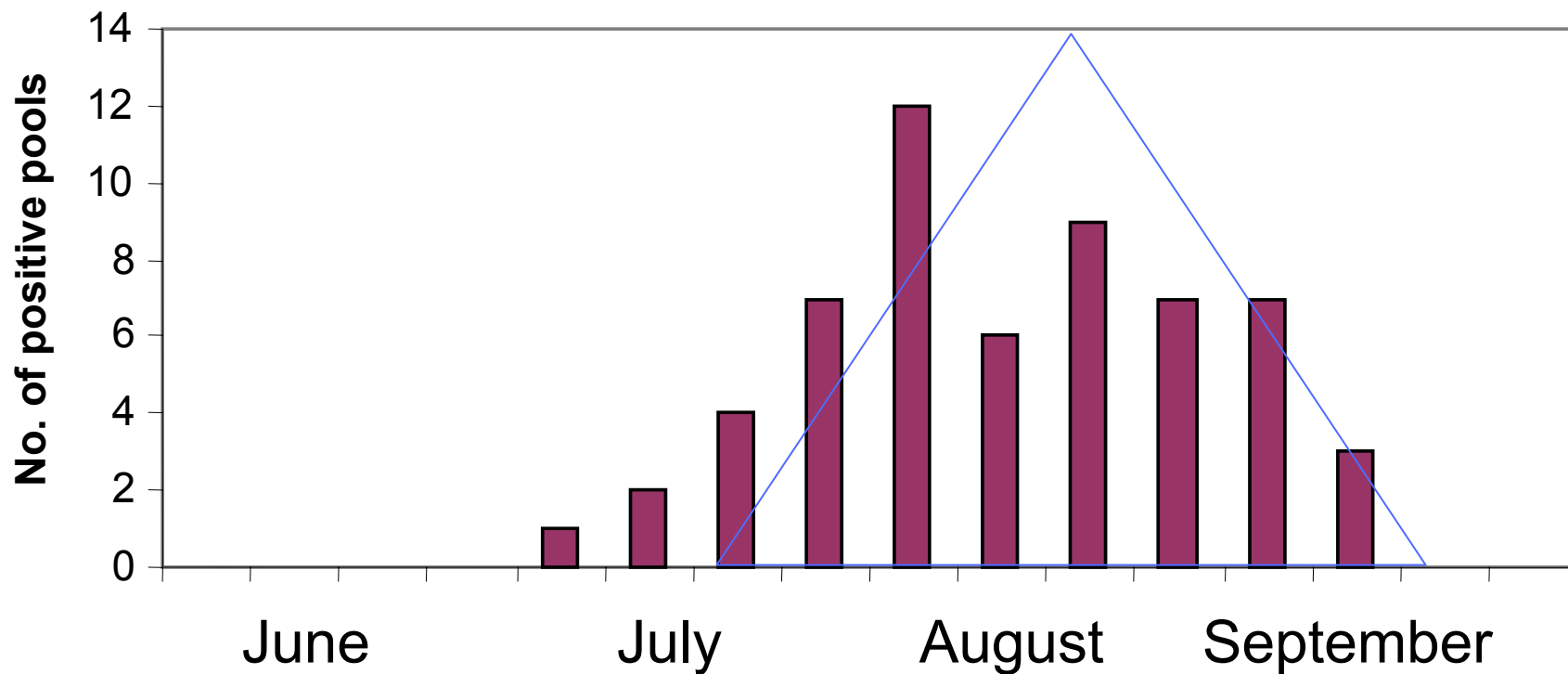
Golf courses and parks

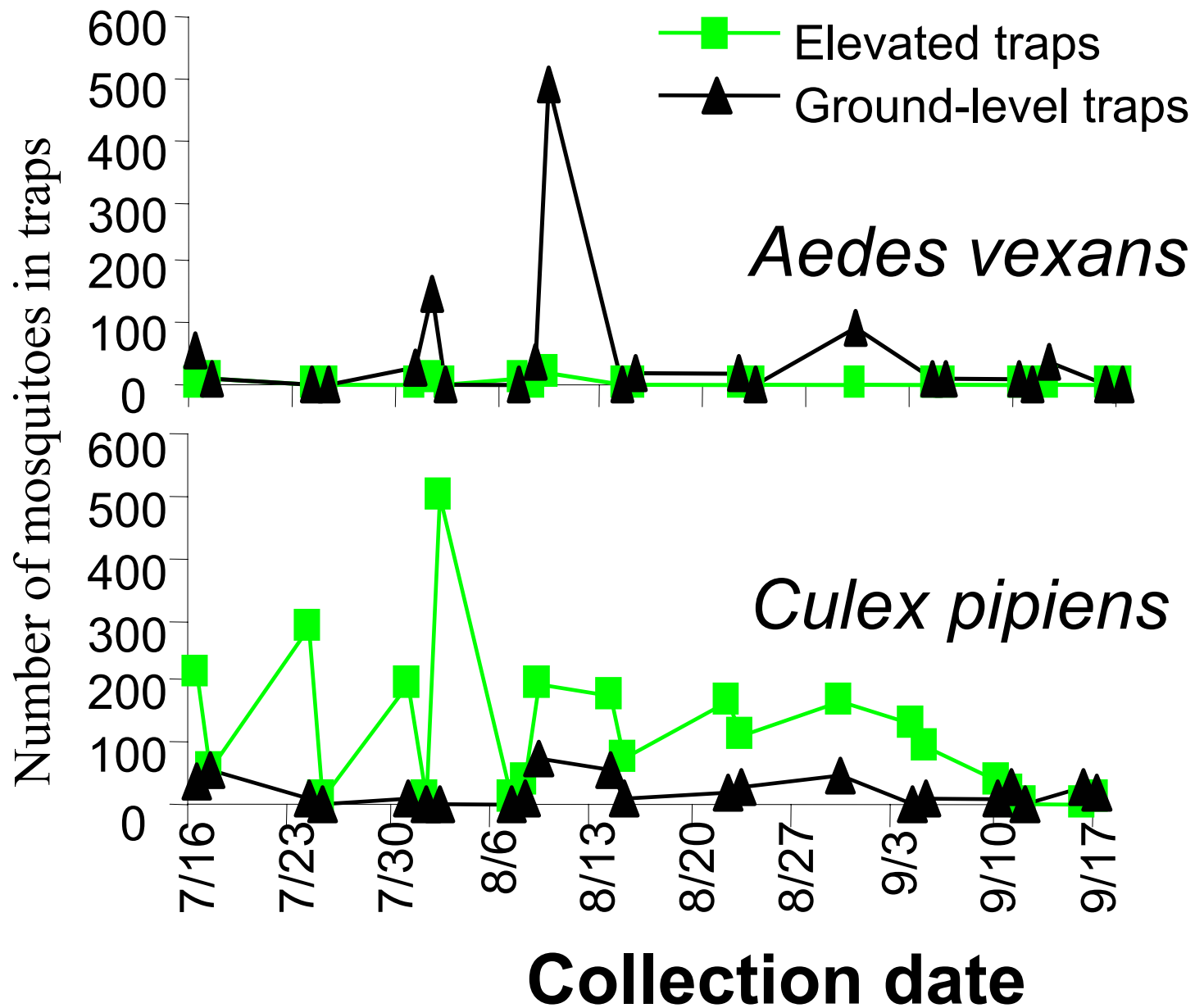
Sites of dead bird reports

West Nile virus, PCR positive mosquitoes, Michigan, 2002

Species	No. tested	No. pools	No. positives	estim. MFIR*
Culex spp	5768	431	27	4.7
Cx. pipiens	1182	121	23	19.5
Cx. restuans	58	25	3	51.7
Cx. salinarius	318	30	2	6.3
Cx. territans	2	2	0	0.0
Cq. perturbans	2000	201	1	0.5
Culiseta spp.	188	28	0	0.0
Ochl. triseriatus	76	30	0	0.0
Ochl. trivittatus	569	31	1	1.8
Or.signifera	7	6	0	0.0
Ochl. canadensis	32	7	0	0.0
Ae. vexans	2003	188	1	0.5
An. punctipennis	270	83	0	0.0
An. quadrimaculatus	337	74	0	0.0
Ur. sapphirina	14	8	0	0.0
TOTAL	12824	1265	58	4.3

Positive Mosquito Pools by Week of Year, Michigan, 2002

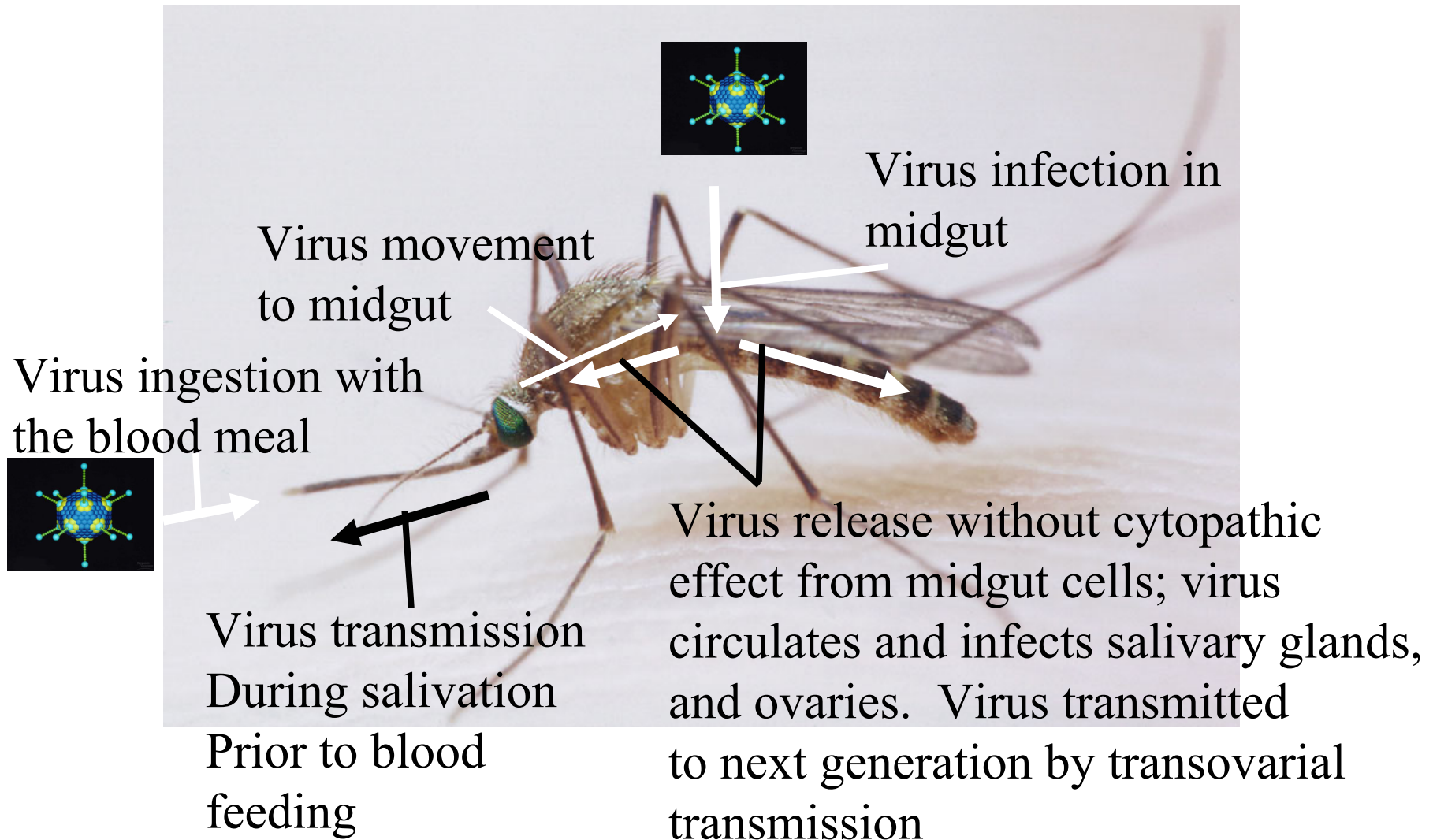




Prevention of Mosquito Borne Disease

- Prevent mosquito bites
 - ~ Personal protection
 - ~ Physical barriers
 - ~ Personal behavior
- Reduce mosquito populations
 - ~ Suppress larval production
 - ~ Reduce adult mosquito population density
- Reduce virus infection rates in mosquito populations
 - ~ Reduce adult mosquito population density (effect kills older mosquitoes by chance)

Virus infection and transmission processes in mosquitoes



Virus acquisition

Virus transmission

Adult mosquito
emergence

1st blood
feeding

2nd blood
feeding

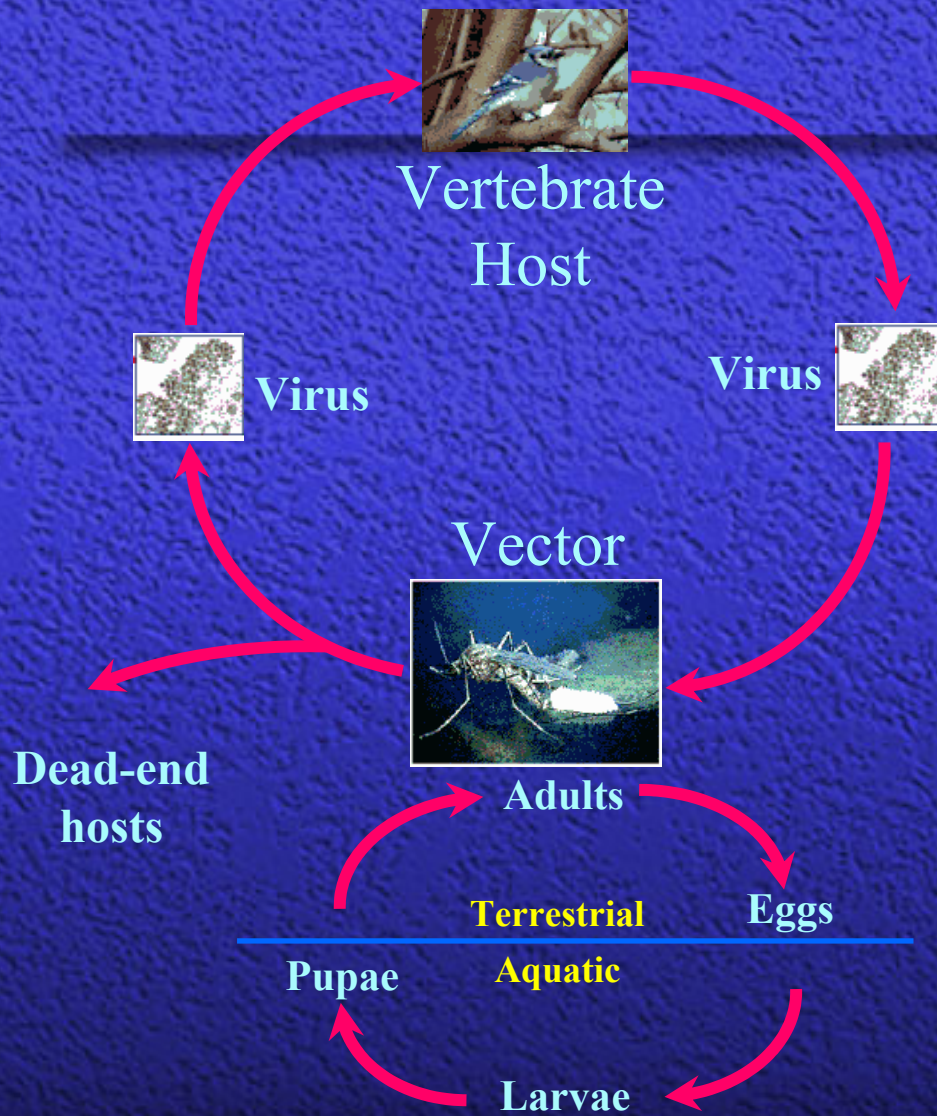
3rd blood
feeding

4th blood
feeding

maturation

TIME





Virus amplification
in birds and
mosquitoes

Disease risk

Control

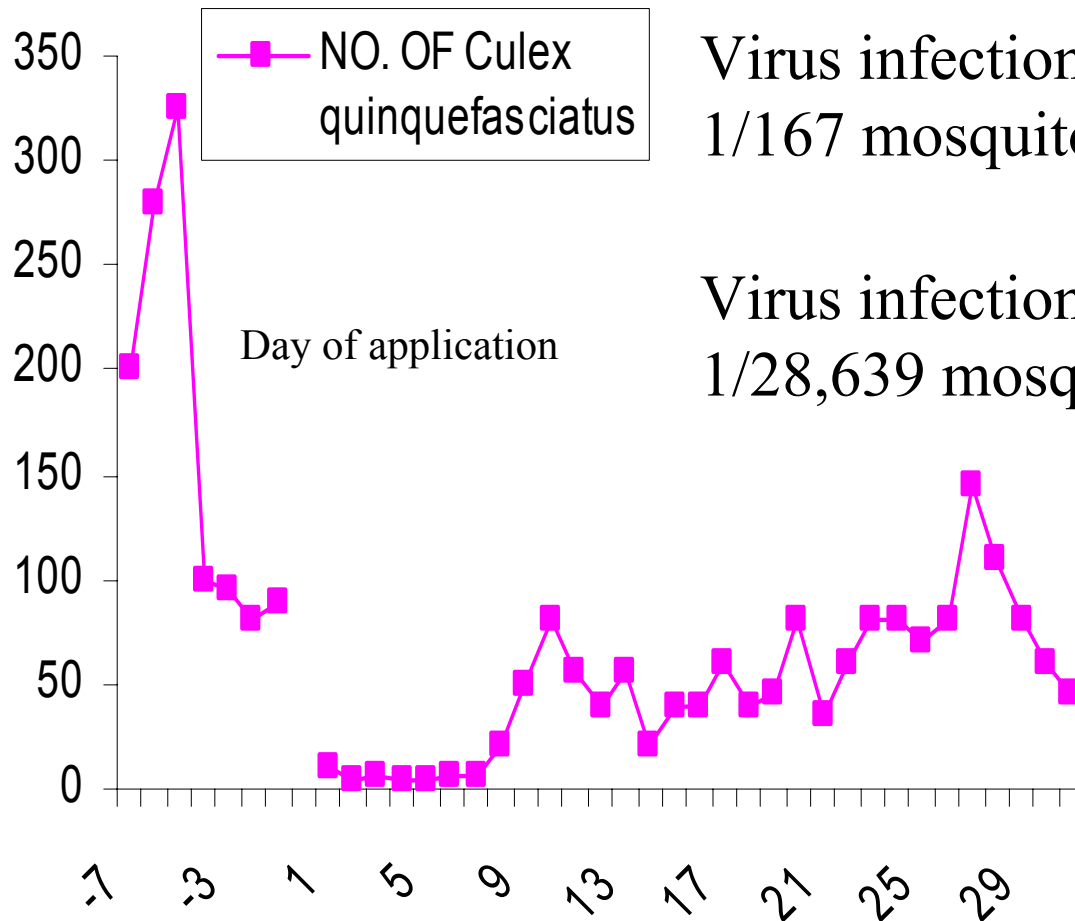
Mosquito population
growth

Control

A M J J A S

Efficacy of aerial ultralow volume application of insecticides to control transmission of SLE virus during an epidemic in Dallas, Texas 1966

AVERAGE NUMBER OF MOSQUITOES
PER SITE SAMPLED



Virus infection rate before spray:
1/167 mosquitoes

Virus infection rate after spray:
1/28,639 mosquitoes

DAY PRE- AND POST APPLICATION

West Nile Virus Infection Rates and Mosquito Control, Michigan, 2002

- Vector Control Districts (4 + 2)
- 6,844 Culex in 579 pools tested
- 25 pools positive
- Minimum field infection rate = 3.65/1,000
- No vector control
- 1,052 Culex in 106 pools
- 30 pools positive
- Minimum field infection rate = 28.5/1,000

